Virtual Reality over High-Speed Networks

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This special issue, "VR and the Net," focuses on supercomputing-to-VR and VR-to-VR communications over high-speed networks, enabling researchers to investigate solutions to complex problems over distance. Specifically, some of the applications featured in the Global Information Infrastructure (GII) Testbed event at the ACM/IEEE Supercomputing '95 (SC'95) conference in San Diego in December 1995 are described. Tom DeFanti, as SC'95 Information Architect, was responsible for all conference networking, audio/visual support, and the GII Testbed. Maxine Brown co-chaired the GII Testbed and Rick Stevens was chief architect of the experimental networking activities.

The GII Testbed featured interactive 2D and 3D scientific visualization and VR demonstrations of research projects that used distributed, real-time, heterogeneous computing, large datasets, remote instrumentation, collaboration, and advanced graphical display devices to attack large-scale problems. The applications were computed in scientists' numerical laboratories and then transmitted over the I-WAY to the SC'95 convention center.

The I-WAY, or Information Wide Area Year, was the first truly national-scale, high-performance, applications-driven, ATM (Asynchronous Transfer Mode) testbed. The I-WAY integrated existing high-speed networks, including the vBNS, AAInet, ESnet, ATDnet, CASA, and MAGIC, for use by research teams participating in the SC'95 GII Testbed. To help standardize the I-WAY, key sites donating remote computing resources installed point-of-presence (I-POP) computers as their gateways to the I-WAY. The I-POP machines were configured uniformly and possessed a standard software operating environment called I-Soft to overcome issues of heterogeneity, scale, performance, and security. The I-POPs simplified interactions with the network but also provided an easy means for institutions to disconnect from the superhighway if it were to become necessary.

The I-WAY was designed as an experiment to help ferret out the right questions and be a cyber-laboratory to work out answers and new questions in turn. *Testbed* is the term given to such experiments. The basic problem with large-scale parallel processing is decomposing the problem so that individual processors can do significant work in parallel with lots of other ones, yet be able to keep the data updated in sync. Certain problems decompose elegantly, some very badly, and most of those in-between exhibit sensitivity to the number of processors, the amount of memory each processor has and how efficiently they cross communicate. The communication mechanisms are the focus of lots of study now, and the I-WAY was a national facility for such experiments.

The VR displays (the CAVE™, ImmersaDesk™, and Infinity Wall™) used for the SC'95 GII Testbed were originally developed to stress test the networks and supercomputers. The CAVE (Cave Automatic Virtual Environment) is a 10x10x9-foot room-sized, multi-person, high-resolution 3D video and audio environment. The ImmersaDesk is a drafting-table format virtual prototyping device designed as a single-user application development station. The Infinity Wall is a paneled, large-screen, high-resolution, stereo, projection display well suited for large audiences. The CAVE library and desktop simulator software package, described in this issue in the article "A Hardware-Independent Virtual Reality Development System" by Dave Pape, was extended to work with all three of these graphical displays, so projects designed in any of these virtual environments could be displayed in the others.

The SC'95 I-WAY/GII Testbed activities enabled us to attract and nurture world-class applications. To our knowledge, no other coordinated program exists for full integration from applications to bitways and from supercomputers to VR. There are, of course, Gigabit Testbeds that become suppliers of techniques and experimental services, but the Gigabit Testbeds cry out for real users. Now that SC'95 is over, we intend to continue the I-WAY and I-POP/I-Soft efforts, with emphasis on VR-based application drivers. In addition, we will continue to enhance our VR displays to track the developments in the simulation and graphics industry. We know full well we are just starting to have enough polygons and texture memory to function at all in VR, and we are just beginning to harness the real-time power of supercomputers. With no exaggeration, computational scientists need four orders of magnitude improvement in graphics and processor performance to do in real-time VR what they now do on frame-at-a-time scientific visualizations. Similarly, 155Mb networking is barely enough for intense point-to-point VR with supercomputing; upgrades to OC-48 and OC-192 experimental networks are clearly desirable, especially for multiple-VR sessions.

SC'95 GII Testbed and I-WAY activities were organized by researchers at the Electronic Visualization Laboratory at the University of Illinois at Chicago, Argonne National Laboratory, and the National Center for Supercomputing Applications at the University of Illinois at Urbana-Champaign. Funding was provided by the ACM/IEEE SC'95 conference, the U.S. Department of Energy, and the National Science Foundation, grant CDA-9303433, with major support from the Defense Advanced Research Projects Agency.

http://www.ncsa.uiuc.edu/General/Training/SC95/GII.HPCC.html

<<FOOTNOTES>>
CAVE and ImmersaDesk are trademarks of the University of Illinois Board of Trustees.

The CAVE, ImmersaDesk, and Infinity Wall are research projects of the Electronic Visualization Laboratory (EVL) at the University of Illinois at Chicago; EVL developed the Infinity Wall in collaboration with the University of Minnesota and the National Center for Supercomputing Applications.

Bios

Thomas A. DeFanti is director of the Electronic Visualization Laboratory, a professor in the department of Electrical Engineering and Computer Science, and director of the Software Technologies Research Center at the University of Illinois at Chicago. He is also the associate director for virtual environments at the National Center for Supercomputing Applications at the University of Illinois at Urbana-Champaign. DeFanti's research interests include virtual environments, scientific visualization, new methodologies for informal science and engineering education, paradigms for information display, algorithm optimization for scalable computing, sonification, and abstract mathematical visualization. Together with his colleague Dan Sandin, DeFanti is receiving recognition for conceiving the CAVE virtual reality theater in 1991. He has been an active volunteer in ACM SIGGRAPH and IEEE for over 20 years, is the recipient of the 1988 ACM Outstanding Contribution Award, and is an ACM Fellow.

Rick Stevens is division director of the Mathematics and Computer Science Division of Argonne National Laboratory. He also directs Argonne's Computing and Communications Infrastructures Futures Laboratory. He is pursuing a research program that combines high-performance computing, collaborative environments, and computational science.

Maxine D. Brown is the associate director of the Electronic Visualization Laboratory at the University of Illinois at Chicago (UIC), responsible for the funding, documentation, and promotion of its research activities. She is also the associate director for Marketing Communications at the National Center for Supercomputing Applications at the University of Illinois at Urbana-Champaign. Prior to coming to UIC in 1986, Brown was a consultant in the computer graphics industry, specializing in professional and technical communications; she also held positions at Digital Productions, ISSCO, and Hewlett-Packard. Brown has been active an active volunteer in ACM SIGGRAPH for almost 20 years.